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Global estimates of energy-growth nexus: Application of seemingly unrelated regressions

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ABSTRACT

As the world struggles to emerge from a global recession and financial crisis, countries are looking for solutions to improve domestic economic performance and put people back to work. Global energy demand and prices have been resilient during the recession, leading policy-makers in countries with the potential to produce energy to look to that sector as a potential engine for economic growth. The objective of this study is to undertake an empirical study on linkages among energy consumption, economic growth, FDI, relative price and financial development (i.e., broad money supply – M_2) in low income, middle income, high income non-OECD, high income OECD, South Africa, Middle East and North Africa (MENA) and the aggregate data of the World over a period of 1975–2011. Data is analyzed by the Im–Pesaran–Shin (IPS) test of unit root to find out the order of integration. The long-run relationship is investigated through the Pedroni [37] test of panel cointegration. At last, the Seemingly Unrelated Regression (SUR) method is used for estimation of the impact of growth factors on energy consumption in these regions. The results reveal that each variable seem to have a unit root at level, so we could investigate cointegration of the series at level. On the basis of Pedroni test, we can bring to a close that series are cointegrated. The results of seemingly unrelated regression (SUR) suggests that GDP per capita has a positive impact on energy consumption in low income, middle income, South Africa, MENA and aggregate data of the World. However, in high income OECD and non-OECD regions, there is no significant relationship been found in both regions. FDI plays a pivotal role in increasing energy demand in middle income, high income OECD and non-OECD region which implies that whatever other benefits may accrue from FDI, it should not be expected to generate sufficient energy in South Africa, MENA and the World directly. FDI enhancement policies should be supplemented to stimulate growth in those regions. Broad money supply exerts positive impact on energy demand in low income, middle income, high income non-OECD and MENA regions. Finally, relative prices has either a positive impact i.e., middle income region and/or a negative impact on energy consumption i.e., low income, high income OECD and MENA region. The results conclude that lower energy prices reduce input costs for nearly all goods and services in the regions, thus making them more affordable.

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1. Introduction

The world has been reeling from the financial crisis with reverberations being felt throughout the real economy on production, consumption, jobs and well-being. Energy is the "oxygen" of the economy and the life-blood of growth, particularly in the mass industrialization phase that emerging economic giants are facing today [49]. According to IEA [19] data from 1990 to 2008, the average energy use per person increased 10% while world population increased 27%. Regional energy use also grew from 1990 to 2008: the Middle East increased by 170%, China by 146%, India by 91%, Africa by 70%, Latin America by 66%, the USA by 20%, the EU-27 block by 7%, and world overall grew by 39%.

Green renewable energy is type of energy, which is usually produced by natural resources, for example wind, sunlight, rain, tidal energy, geothermal heat, and many more. In 1800′s, most of the energy in this world came from the renewable energy resources. However, the use of natural energy has already decreased since the findings of non-renewable energy resources, such as coal, natural gas, and also oil. It is dangerous for the earth because most of the non-renewable energy resources are not eco-friendly [38]. According to American Institute of Biological Sciences [3] report an "enormous" increase in energy supply will be required to meet the demands of projected world population growth and lift the developing world out of poverty without jeopardizing standards of living in most developed countries. Investing in energy efficiency creates jobs, fosters economic growth and improves energy security for countries that lack domestic fossil fuel resources. Of the three objectives of Sustainable Energy for All, improving energy efficiency has the clearest impact on saving money, improving business results, and delivering more services for consumers – better refrigerators that cost the same but use less energy; new vehicle designs that travel further on less fuel; and buildings that require less energy to heat and cool [46].

Global energy consumption has seen declining growth rates. In recent years, the growth of energy consumption in developed countries has been flat or decreasing. In 2010, primary energy consumption in OECD countries grew by 3.5%, similar to the growth rate of a decade ago. Primary energy consumption in non-OECD countries went up by 7.5%. Developing countries, led by the BRIC countries (Brazil, Russia, India and China), have seen decreasing energy consumption per unit of GDP, while total energy demand increases rapidly. Due to political unrest in the Middle East and North Africa, crude oil futures prices and spot prices were severely volatile with an upward trend. UK North Sea Brent oil price reached US$ 126.65 per barrel in April 2011, the record high since the beginning of the financial crisis. Influenced by the situation in Iran, oil prices have trended upwards recently. As compared with Libya, issues in Iran have a greater impact on oil prices. In the event the situation deteriorates in Iran, oil prices will soar [13].

Worldwide, nations are beginning to face up to the challenge of sustainable energy, in other words, to alter the way that energy is utilized so that social, environmental and economic aims of sustainable development are supported. South Africa is a developing nation with significant heavy industry, which is by its nature energy intensive. This energy intensive economy largely relies on indigenous coal reserves for its driving force. At first sight there would appear to be an apparent paradox between using less energy and developing a healthy and prosperous nation based on energy intensive activities. This is not the case. In recent years energy efficiency has significantly gained in stature and has become recognized as one of the most cost-effective ways of meeting the demands of sustainable development [48]. Zhang [53] induce for MENA governments to improve energy efficiency is to address pressing domestic concerns, such as urban air pollution, energy security, economic competitiveness, the fiscal cost of energy subsidies and the balance of payments. However, improved energy efficiency is also seen as the most promising route for reducing the region's green house gas (GHG) emissions. Vietnam is among the top five countries in the world most vulnerable to climate change, and natural disasters are causing economic losses of 1.5% of gross domestic product annually. Many poor depend on natural resources for their livelihood, yet supplies are threatened by unsustainable practices. Insufficient investment in water supply and sanitation, solid waste management, and transport is contributing to pollution. To address energy and sustainable development issue, the World Bank has financed investments to increase access to basic services in water and sanitation, energy, and roads as well as promotion of agriculture livelihoods. World Bank further support for more sustainable urbanization has included financing of investment in water and sanitation, transport, and urban upgrading [50].

The WHO Air Quality Guidelines recommend reduction of air pollution to a specified level in all regions of the world. No separate guideline values should be proposed for low-income countries where pollution, and its burden on health, is much higher than in Europe or the USA. However, to facilitate progress towards clean air, the Air Quality Guidelines propose "interim targets" promoting steady progress towards meeting the WHO guidelines [27]. The global recession and financial crisis that began in 2008, bring a new focus to decisions about energy. Many parts of the developed world still face sluggish economic growth and risks from financial crises. Financial institutions lowered their forecasts for world economic growth, impacting an energy sector tied to capital markets. Therefore, oil prices remain volatile, and the global economy is still looking gloomy (Weforum, 2012). Global foreign direct investment (FDI) inflows rose modestly in 2010, following the large declines of 2008 and 2009. At $1.24 trillion in 2010, they were 5% higher than a year before (Fig. 1). This moderate growth was mainly the result of higher flows to developing countries, which together with transition economies – for the first time – absorbed more than half of FDI flows. While world industrial production and trade are back to their pre-crisis levels, FDI flows in 2010 remained some 15% below their pre-crisis average, and 37% below their 2007 peak [47].

The year 2011 was a challenging one for the global FDI market. Natural disasters in Asia-Pacific and economic and political instability in Europe, North Africa and the Middle East led many companies to put on hold their FDI plans, leading to a sharp decline in FDI in many countries. North America, with brighter economic prospects and a 'shale rush', achieved solid FDI growth. Likewise, companies continued to be attracted to the investment opportunities in Africa and Latin America, with 20%-plus growth in FDI in each region. Brazil was again the star performer, with a 38%

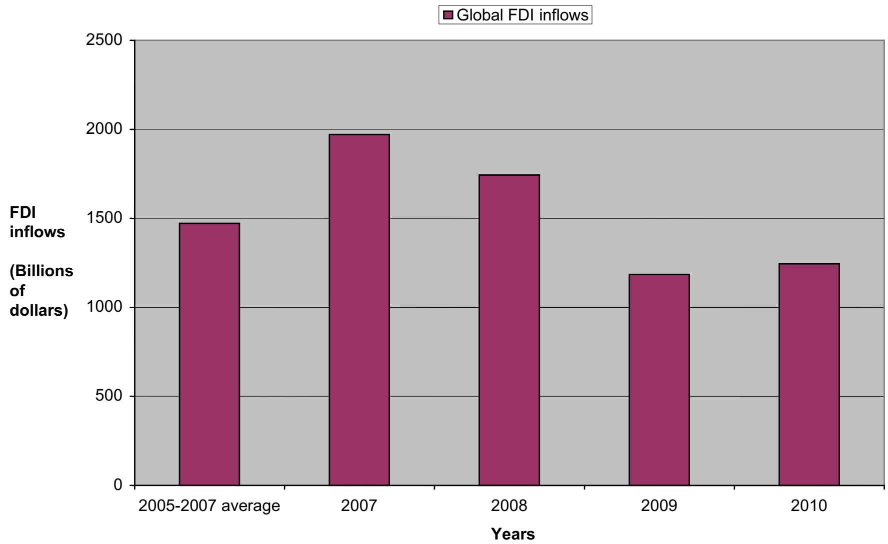

Fig. 1. Global FDI inflows (Billions of Dollars).

increase in FDI projects [11]. The next stage of financial development has to be finding mechanisms for energy exporters to diversify their future income in a way that is fair to current and future generations, robust and credible. Energy prices, representing a long-lived asset, are always going to be volatile. But there are ways to potentially make the volatility less economically damaging [40].

In addition to the energy sector's economic contributions in general, relatively lower and stable energy prices help stimulate the economy. First, lower energy prices reduce expenses for consumers and businesses, increasing disposable income that can be spent in other ways. Second, lower energy prices reduce input costs for nearly all goods and services in the economy, thus making them more affordable. The converse is also true: relatively higher energy prices place a drag on economic growth everywhere except in economies that are dominated by energy production. Global oil prices entered a long upward swing in 2004, and the trend accelerated sharply in 2007. This price rise contributed to the deep recession in the developed world that began in late 2007. Rising energy prices took purchasing power away from consumers, particularly from lower-income groups. They also brought about deterioration in consumer sentiment and an overall slowdown in consumer spending [49].

According to Azevedo [5], p. 27,

> "*The inescapable fact is that all these developments are producing a virtuous cycle that is fostering the creation of high-quality jobs, helping to generate income and reduce inequalities. The pre-salt fields are a striking example of how the oil and gas industry – in addition to providing the world with much-needed energy– can act as a catalyst to improve socioeconomic conditions*".

The above discussion confirms the strong relationship between energy and growth factors in the developed and developing world. The objective of this study is to empirical examine the linkages among energy consumption, economic growth, FDI, relative prices and money supply in different regions of the world through panel cointegration and seemingly unrelated regression technique.

The study is divided into following sections: after introduction which is presented in Section 1 above, Section 2 presents review of literature. Data source and methodological framework are shown in Section 3. Results are discussed in Section 4. Final section concludes the study.

2. Literature review

A large body of economic literature supports the premise that, in addition to energy consumption and other important factors, the performance and long-term economic growth and welfare of a country are related to its degree of financial development. Kalyoncu et al. [25] investigate the relationship between energy consumption and economic growth in Georgia, Azerbaijan and Armenia during the period of 1995–2009. The results reveal that for Georgia and Azerbaijan are not cointegrated and have no long-run relationship between energy and economic growth. As in case of Armenia these two variables are cointegrated and there is unidirectional causality running from per capita GDP to per capita energy consumption. Ilhan Ozturk et al. [20] uses the panel data of energy consumption (EC) and economic growth (GDP) for 51 countries from 1971 to 2005. The results of this study reveal that both energy consumption and GDP are cointegrated for all three income group countries. The panel causality test results reveal that there is long-run Granger causality running from GDP to EC for low income countries and there is bidirectional causality between EC and GDP for middle income countries. He et al. [16] investigates the existence and direction of Granger causality between energy consumption, economic growth and foreign direct investment in China, over the period 1985–2010. The result suggests a unidirectional Granger causality running from GDP to energy use and foreign direct investment, and a unidirectional Granger causality running from energy consumption to FDI. Song et al. [42] examines China's indicators of economic growth and changes in energy consumption brought by technological progress since 1986. The results show that, China's high-speed economic growth is still largely dependent on massive energy consumption. Song et al. [43] further employed slacks-based measurement (SBM) model to measure the environmental efficiency of provinces in China from 1998 to 2009. In addition, Tobit model empirically tests the impact of influencing factors on the environmental efficiency. The results demonstrate the low value of the environmental efficiency of each province with descending trend overall and the distinct differences between the environmental efficiency of those provinces. GDP per capita dependent on foreign capital and trade, environmental awareness and population density have positive impacts on environmental efficiency. The proportion of the secondary industry in the GDP shows a significantly negative impact on the environmental efficiency.

Kotrajaras [26] examines the effect of FDI on the economic growth of 15 East Asian countries over a period of from 1990–2009.

The results show that FDI does not necessarily enhance economic growth. FDI had a positive effect on the economic growth only in the countries that have the appropriate economic conditions. Hussai and Kimuli [18] explore different factors responsible for variation in foreign direct investment to developing countries by using panel data of 57 low and lower middle income countries for last ten years (2000–2009). This study finds that market size is the most important determinant of foreign direct investment to developing countries. Hassan [15] examines the important factors that contribute to FDI and economic growth in the world and compares them with those of MENA countries by using a panel data of 95 countries and eight MENA countries over 1980–2001 period. The results reveal that both growth and FDI are related to a host of macroeconomic, ICT and globalization variables. Onyeiwu [36] investigates whether the determinants of FDI affect MENA countries differently. The results indicate that some of the variables that influence FDI flows to developing countries are not important for flows to MENA countries. These include the rate of return on investment, infrastructures, economic growth, and inflation. While trade openness increases FDI flows to MENA countries, corruption/bureaucratic red tape were found to reduce flows to the region. Thus, trade liberalization and privatization are important preconditions for FDI flows to the region. Okeahalam [35] assesses the relationship between a number of economic development and institutional variables and the level of financial market development in the Middle East and North Africa (MENA) region. Correlation matrices support the view that the institutional environment in which financial markets function is important, as this reinforces the efficient allocation of economic rights that are essential for markets to function optimally. However, regression estimates indicate that infrastructure development and the degree of openness of an economy are the most robust indicators for the development and effective functioning of financial markets in the MENA region. Memon et al. [34] examines the impact of FDI by using panel regression model, mainly on two factors –Labor productivity and GDP growth rate through financial development in a panel data of 50 Asian countries from 2001–2008. The results reveal that FDI is increasing in those Asian countries where financial markets are in strong position otherwise GDP growth is negatively affected by FDI. Djoumessi [8] empirically explore the relationship and the causal link between financial development and economic growth in two sub-Saharan African countries i.e., Cameroon and South Africa, between 1970 and 2006. The results reveal that in both countries there is a positive and long-term relationship between all the indicators of financial development and economic growth. In Cameroon, the study found that financial development causes economic growth, whereas in South Africa economic growth causes financial development.

Both energy and growth factors are interlinked and this channel is expedited through financial development. In the subsequent section, an analysis has been carried out to find the long-run relationship between energy consumption, economic growth, FDI, financial development and relative prices in different regions of the world.

3. Data source and methodological framework

In this study, we consider an aggregate data of low income, middle income, high income OECD & non-OECD, South Africa, MENA and World which constitutes balanced panel data over the period of 37 years from 1975–2011. The number of variables has been considered to evaluate energy-growth nexus in different regions of the world i.e., energy consumption (i.e., kg of oil equivalent per capita); GDP per capita (current US$); relative price of energy to non-energy goods (measured by the ratio of the price index to the GDP deflator, annual %), foreign direct investment, net inflows (% of GDP); money and quasi money as % of GDP; liquid liabilities (M3) as % of GDP; domestic credit provided by banking sector as % of GDP (BC) and domestic credit to private sector as % of GDP (PRI). These variables are selected because of their vital importance in different regions of the world. All of the data is taken from *World Development Indicators* published by the World Bank [51].

To examine the impact of growth factors on energy consumption in different regions of the world, we used GDP per capita, FDI, relative price and financial development variables as independent variables covering the period of 1975–2011. The variables are used without natural log because there are few negative observations. The general equation of the model has been specified as follow:

$$(EC)_{it} = \alpha + \beta_{1t}(GDP_{PC})_{it} + \beta_{2t}(FDI)_{it} + \beta_{3t}(RELP)_{it} + \beta_{4t}(FD)_{it} + \varepsilon_{it} \quad (1)$$

where

EC = energy consumption (kg of oil equivalent per capita);
GDP_{PC} = GDP per capita (current US $);
FDI = Foreign Direct Investment, inflows (% of GDP);
RELP = relative prices (measured by the ratio of the price index to the GDP deflator, annual %);
FD = financial development indicator (% of GDP);
α = intercept;
β_1 = Coefficient of economic growth;
β_2 = Coefficient of FDI;
β_3 = Coefficient of relative prices;
β_4 = Coefficient of financial development;
t = 1, 2,…,37 periods;
i = 1,...,7 regions; and
ε_t = error term.

In order to find out the long run relation, we first check the order of integration by applying the unit root tests given by Im–Pesaran–Shin (IPS). Then, after getting the order of the integration, Pedroni's test of cointegration is applied. Finally, a Seemingly Unrelated Regression (SUR) test is applied to find out whether growth factors have an impact upon energy consumption in different regions of the world.

3.1. Panel unit root test

The first step in determining a potentially cointegrated relationship is to test whether the variables involved are stationary or non-stationary. If all the variables are stationary traditional estimation methods can be used to estimate the (causal) relationship among variables. If, however at least one of the series is non-stationary more care is required. There are many tests available for testing unit root in panel data which are;

- Fisher's (p) test (1932)[12].
- Maddala and Wu [32].
- The Levin–Lin, Chu (LL) tests [30].
- The Im–Pesaran–Shin (IPS) test [21].

Although the Fisher test can be applied but the disadvantage is that the p-values have to be derived through Monte Carlo simulation. So, in this study, we apply Im–Pesaran–Shin (IPS) test for unit root because it does not have only comparative advantage over all other tests but it is appropriate for our data as well. The IPS test provides separate estimation for each i section, allowing different specifications of the parametric values, the residual variance and

the lag lengths. Their model is given by:

$$\Delta Y_{i,t} = \alpha_i + \rho_i Y_{i,t-1} + \sum_{k=1}^{n} \phi_k \Delta Y_{i,t-k} + \delta_i t + u_{it} \tag{2}$$

while now the null hypothesis and the alternative hypothesis are formulated as:

$H_0 : \rho_i = 0$

$H_A : \rho_i < 0$

for at least one i.

Thus, the null hypothesis of this test is that all series are non-stationary process under the alternative that fraction of the series in the panel are assumed to be stationary. IPS also suggested a group mean Lagrange multiplier test for testing panel unit roots.

More over IPS test is the most powerful test as compared to the other tests. Another reason for using IPS test is that we have a balanced panel instead of different time series for different samples. In addition, the IPS test is the most cited unit root test in the literature. Another advantage of using the IPS test is that it is based on heterogeneity of the autoregressive parameters (there is a possibility of heterogeneity in the error variances and the serial correlation structure of the errors).

3.2. Panel cointegration test

With confirmation on the integrated order of variables of interest, the question is that they might or might not have a common stochastic trend, or, they might or might not be cointegrated. We resolve this question by looking for a long-run relationship among the variables using the panel cointegration technique. The available methods for panel data cointegration are given as follows.

- Johansen [23]
- Larsson et al. [29]
- Pedroni [37]

This study employs Pedroni's [37] panel-co integration method in order to examine the long-run relationship between growth factors and energy consumption in different regions of the world, as if the independent and dependent variables are co-integrated or have a long-run relationship, the residual e_{it} will be integrated of order zero, denoted I(0). Pedroni uses two types of panel cointegration tests. The first is the "panel statistic" that is equivalent to a unit root statistic against the homogenous alternative; the second is the "group mean statistic" that is analogous to the panel unit root test against the heterogeneous alternative. Pedroni [37] argues that the "panel statistic" can be constructed by taking the ratio of the sum of the numerators and the sum of the denominators of the analogous conventional time series statistics. The "group mean statistic" can be constructed by first computing the ratio corresponding to the conventional time series statistics, and then computing the standardized sum of the entire ratio over the N dimension of the panel. The two versions of the ADF statistics could be defined as:

$$\text{Panel} \quad Z_t = \left(\tilde{s}^2_{NT} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{e}^2_{i,t-1} \right)^{-1/2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{e}_{i,t-1} \Delta \hat{e}_{I,T} \tag{3}$$

$$\text{Group Mean} \quad N^{-1/2} Z_T = N^{-1/2} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{s}_i \hat{e}^2_{i,t-1} \right)^{-1/2} \sum_{t=1}^{T} \hat{e}_{i,t-1} \Delta \hat{e}_{i,t} \tag{4}$$

where $\hat{e}_{i,t}$ represents the residuals from the ADF estimation, $\tilde{s}_{NT}$ is the contemporaneous panel variance estimator, and $\hat{s}_i$ is the standard contemporaneous variance of the residuals from the ADF regression. The asymptotic distribution of panel and group mean statistics can be expressed in:

$$\frac{K_{N,T} - \mu\sqrt{N}}{\sqrt{v}} \Rightarrow N(0, 1)$$

where $K_{N,T}$ is the appropriately standardized form for each of statistics, μm ADF regression is the mean term and v is the variance adjustment term. Pedroni provides Monte Carlo estimates of μ and v [37].

This technique is a significant improvement over the conventional cointegration tests applied on a single series. As explained in [37], conventional cointegration tests usually suffer from unacceptable low power when applied on data series of restricted length. The Panel cointegration technique addresses this issue by allowing one to pool information regarding common long-run relationships between a set of variables from individual members of a panel. Further, with no requirement for exogenity of the regressors, it allows the short-run dynamics, the fixed effects, and the cointegrating vectors of the long-run relationship to vary across the members of the panel. Furthermore, it provides appropriate critical values even for more complex multivariate regressions. [37] refers to seven different statistics for testing unit roots in the residuals of the postulated long-run relationship. Of these seven statistics, the first four are referred to as panel cointegration statistics; the last three are known as group mean panel cointegration statistics. In the presence of a cointegrating relation, the residuals are expected to be stationary. A positive value for the first statistic and large negative values for the remaining six statistics allows rejection of the null hypothesis.

3.3. Seemingly unrelated regressions (SUR)

The seemingly unrelated regression (SUR) method, also known as the multivariate regression, or Zellner's method, estimates the parameters of the system, accounting for heteroskedasticity and contemporaneous correlation in the errors across equations. The model can be estimated equation-by-equation using standard ordinary least squares (OLS). Such estimates are consistent, however generally not as efficient as the SUR method, which amounts to feasible generalized least squares with a specific form of the variance-covariance matrix. Two important cases when SUR is in fact equivalent to OLS, are: either when the error terms are in fact uncorrelated between the equations (so that they are truly unrelated), or when each equation contains exactly the same set of regressors on the right-hand-side.

The SUR model can be viewed as either the simplification of the general linear model where certain coefficients in matrix B are restricted to be equal to zero, or as the generalization of the general linear model where the regressors on the right-hand-side are allowed to be different in each equation. The SUR model can be further generalized into the simultaneous equations model, where the right-hand side regressors are allowed to be the endogenous variables as well.

4. Empirical findings

4.1. Panel unit root estimation

We used the Im–Pesaran–Shin [21] test in order to find out the order of the integration, by testing whether growth factors have an impact upon energy consumption in low income, middle income, high income OECD and non-OECD, South Africa, MENA and World. The results of the panel unit root tests are presented in Table 1.

The results of panel unit root test with individual trend and intercept; suggest that EC, GDP_{PC}, FDI, CPIDEF and M_2 do not

Table 1
Im, Pesaran and Shin test of unit root.

Variables	Test for unit root in	Lag length	Decision
EC	Level	0	Stationary at level i.e., I(0)
GDP_{PC}	Level	0	Stationary at level i.e. I(0)
FDI	Level	0	Stationary at level i.e. I(0)
CPIDEF	Level	1	stationary at level i.e. I(0)
M_2	Level	0	Stationary at level i.e. I(0)
LL	Second difference	2	Non-stationary at level but stationary at second difference i.e., I(2)
BC	Second Difference	1	Non-stationary at level but stationary at second difference i.e., I(2)
PRI	Second Difference	3	Non-stationary at level but stationary at second difference i.e., I(2)

Note: The lag length is selected based on SIC criteria, this ranges from lag zero to lag three.

Table 2
Pedroni Residual Cointegration Test.
Source: Calculated by the authors.

	Statistic
Panel ν-Statistic	0.724
Panel rho-Statistic	−1.628
Panel PP-Statistic	−2.824
Panel ADF-Statistic	−2.891

contain a panel unit root, as the t-value of EC is −4.16 at level with zero lag, GDP_{PC} is −4.14 at level with zero lag, FDI is −3.67 at level with zero lag, CPIDEF is −3.98 at level with lag one and M_2 is −3.78 at level with zero lag. However, LL, BD and PRI are non-stationary at level but stationary after taking second difference due to this reason, we exclude LL, PRI and BC from our analysis. Certainly, these financial development (FD) indicators are highly correlated, but no consensus evidence of which variable is most appropriate for measuring FD ([44]). With the response to Table 1, only broad money supply (M_2) represents the overall development in the financial sector in this study.

4.2. Panel cointegration estimation

In the second step, after knowing the order of integration we applied the test of cointegration given by Pedroni [37]. Results are given in Table 2.

The result shows that first panel statistics are positive i.e., Panel ν-Statistic=0.724, while the rest of three panel statistics are negative i.e., rho=−1.628; PP=−2.824 and ADF=−2.891. On the basis of Pedroni test we can conclude that the series are cointegrated and have a long run relationship.

4.3. Estimation of seemingly unrelated regression (SUR)

Finally, we used Pooled Estimation of seemingly unrelated regression (SUR) approach. In this model we used one lag for estimating the equations. The optimum lag length is found through Schwarz Information Criteria (SIC). Results are reported in Table 3.

The results suggest that, both GDP_{PC} and broad money supply has a positive impact on increasing energy consumption while there is negative impact of FDI and relative prices on decreasing energy consumption in low income region. The results conclude that the growth in GDP per capita leads to energy consumption, this means that the low income region is still on an unrestrained growth path [10]. Thus the outcomes of estimation support the evidence that energy sector is an important part of the economies of the low income region and it has dynamic affect on the economic standing. The energy sector needs proper attention of the governments of low income countries as flawed, defective and misguided policies can injure the economy gravely for a long period of time [39]. Our results further implies that sound and developed financial system in low income region may attract investors; boost the stock market and improve the efficiency of economic activities in the region [54]. According to Beakert and Harvey [6], liberalization of financial markets leads to economic growth which helps the advancement of technology, reduction of information cost and profitability of investment in the regions. Energy consumption is essential for economic growth and any energy shock may affect the long-run economic development of low income region. Financial development measures such as strengthening financial institutions controlling money supply efficient allocation of financial resources can be used to promote efficient energy use in the long-run [24]. To reduce the energy consumption intensity while expanding FDI scale, low income region should adopt unified energy-saving and emission-reducing requirements to FDI enterprises and domestic ones. Meanwhile, low income region increases the foreign investment proportion in the technology-intensive industries and encourage FDI enterprises to use and exchange advanced energy-saving technologies. Moreover, this region should adjust the distribution industry structure of FDI to optimize the industrial structure adjustment [45]. Prices of various energy forms have been decreasing, due to economies of scale and technology, the expectation for the future, however, is the opposite in low income region [31].

In case of middle income region, all study variables i.e., GDP per capita, FDI, relative prices and financial development has a positive and significant impact on increasing energy demand in middle income region. GDP per capita is one of the key components of the energy consumption. FDI is another important factor for the energy consumption and one of the major contributors for the demand of more energy resources. Relative prices and financial development in the economy has a positive relationship with the energy use and hence it is one of the important factors of the total energy consumption. In addition to the energy sector's economic contributions in general, relatively lower and stable energy prices help stimulate the economy. First, lower energy prices reduce expenses for consumers and businesses, increasing disposable income that can be spent in other ways. Second, lower energy prices reduce input costs for nearly all goods and services in the economy, thus making them more affordable [49]. As evidence from the results, the more the region develops economically; the demand for energy resources also increases [14].

The results of high income non-OECD region suggests that only FDI and broad money supply has a significant impact upon energy consumption, while, GDP per capita and relative prices doesn't have any significant impact upon the energy consumption. The results imply that energy conservation policies do not affect economic growth of high income non-OECD region. Same results appeared in case of high income OECD region where GDP per capita does not have any significant impact on increasing energy consumption, however, relative prices and broad money supply exerts a negative impact on energy consumption in the region.

Table 3
Seemingly Unrelated Regression.

Regions	Variables	Coefficient
Low income (LI)	Constant	300.890*
	$(GDP_{PC})_t$	0.502*
	$(GDP_{PC})_{t-1}$	−0.043
	$(FDI)_t$	−27.849*
	$(FDI)_{t-1}$	−11.973*
	$(CPIDEF)_t$	−0.514
	$(CPIDEF)_{t-1}$	−2.323**
	$(M_2)_t$	0.016
	$(M_2)_{t-1}$	0.036**
Statistical Tests for LI	**Adjusted *R*-square**	**0.644**
	***F*-statistics**	**8.698***
Middle Income (MI)	Constant	12.047
	$(GDP_{PC})_t$	0.318*
	$(GDP_{PC})_{t-1}$	0.413*
	$(FDI)_t$	118.581*
	$(FDI)_{t-1}$	−67.812
	$(CPIDEF)_t$	10.306***
	$(CPIDEF)_{t-1}$	9.433***
	$(M2)_t$	−5.477
	$(M2)_{t-1}$	15.572*
Statistical Tests for MI	**Adjusted *R*-square**	**0.931**
	***F*-statistics**	**58.504***
High Income: non-OECD (HIOECD)	Constant	11.624
	$(GDP_{PC})_t$	0.078
	$(GDPPC)_{t-1}$	−0.0002
	$(FDI)_t$	50.931**
	$(FDI)_{t-1}$	−18.632
	$(CPIDEF)_t$	−32.214
	$(CPIDEF)_{t-1}$	19.721
	$(M_2)_t$	2.871*
	$(M_2)_{t-1}$	20.012
Statistical Tests for HINOECD	**Adjusted *R*-square**	**0.940**
	***F*-statistics**	**67.669***
High Income: OECD countries (HIOECD)	Constant	6148.235*
	$(GDPPC)_t$	0.031
	$(GDPPC)_{t-1}$	−0.005
	$(FDI)_t$	72.292***
	$(FDI)_{t-1}$	55.430
	$(CPIDEF)_t$	−3.075
	$(CPIDEF)_{t-1}$	−48.662***
	$(M_2)_t$	−25.046*
	$(M_2)_{t-1}$	7.739
Statistical Tests for HIOECD	**Adjusted *R*-square**	**0.780**
	***F*-statistics**	**16.571***
South Africa (SA)	Constant	1949.325*
	$(GDP_{PC})_t$	0.014
	$(GDP_{PC})_{t-1}$	0.123***
	$(FDI)_t$	5.732
	$(FDI)_{t-1}$	−6.665
	$(CPIDEF)_t$	10.995
	$(CPIDEF)_{t-1}$	9.321
	$(M_2)_t$	14.681
	$(M_2)_{t-1}$	−15.253
Statistical Tests for SA	**Adjusted *R*-square**	**0.433**
	***F*-statistics**	**4.250***
Middle East and North Africa (MENA)	Constant	132.875
	$(GDP_{PC})_t$	0.448*
	$(GDP_{PC})_{t-1}$	0.291**
	$(FDI)_t$	52.127
	$(FDI)_{t-1}$	−61.542
	$(CPIDEF)_t$	−29.910*
	$(CPIDEF)_{t-1}$	8.912
	$(M_2)_t$	−3.342
	$(M_2)_{t-1}$	20.001*
Statistical Tests for MENA	**Adjusted *R*-square**	**0.921**
	***F*-statistics**	**51.712***
World	Constant	1188.235*
	$(GDP_{PC})_t$	0.106*
	$(GDP_{PC})_{t-1}$	0.052***
	$(FDI)_t$	−0.324
	$(FDI)_{t-1}$	2.663
	$(CPIDEF)_t$	−3.931
	$(CPIDEF)_{t-1}$	5.578
	$(M_2)_t$	−1.865
	$(M_2)_{t-1}$	3.448***
Statistical Tests for World	**Adjusted *R*-square**	**0.943**
	***F*-statistics**	**64.143***

* Indicates significance at 1% level.
** Indicates significance at 5% level.
*** Indicates significance at 10% level.

In case of South Africa, only GDP per capita has a significant impact on energy consumption, while remaining variables does not have a significant relationship with the energy consumption in South Africa. The results implied that energy conservation policies may be implemented with little adverse or no effects on economic growth [4].

The results of MENA region conclude that GDP per capita and money supply exerts a significant and positive impact on energy consumption in that region, while, there is negative relationship between relative prices and energy demand. In addition, FDI doesn't have any significant impact upon increasing energy demand in MENA region. FDI enhancement policies should be supplemented by the other measures to stimulate energy requirement in the region. It should also facilitate developing strong local entrepreneurship, create a stable macroeconomic framework as well as improve conditions for productive investments to speed up the process of economic development [52].

The results of aggregate World region show that economic growth and broad money supply both are the key determinant to increase energy demand in the World, while, FDI and relative prices does not sufficient to explain the relationship with energy demand in the aggregate data of World. Financial development stimulates a number of changes within a country including, for example, a reduction in financial risk and borrowing costs, greater transparency between lenders and borrowers, access to greater financial capital and investment flows between borders, and access to the latest energy efficient products and cutting edge technology, all of which can affect the demand for energy by increasing consumption and business fixed investment [41]. Energy conservation policies such as phasing out energy subsidies or elimination of energy price distortions have little adverse or no effects on economic growth. So, energy saving policies is appreciated. Furthermore, government should promote investments on research and development to enjoy new energy savings technology to sustain economic growth [33].

The results of statistical tests appear to be very good in terms of the usual diagnostic statistics. The value of R^2 adjusted for low income region, middle income, high income non-OECD, high income OECD, South Africa, MENA and the World indicates that 64.4%, 93.1%, 94.0%, 78.0%, 43.3%, 92.1% and 94.3% variations in dependent variable has been explained by variations in independent variables. *F*-value is higher than its critical value suggesting a good overall significance of the estimated model for all three countries. Therefore, fitness of the model is acceptable empirically.

5. Summary and conclusion

The global energy map is changing, with potentially far-reaching consequences for energy markets and trade. The objective of this study is to empirically investigate the linkage among

energy consumption, economic growth, FDI, relative price and financial development in low income, middle income, high income non-OECD, high income OECD, South Africa, MENA and the aggregate data of the World over a period of 1975–2011. The results show that except high income: non-OECD and OECD region, GDP per capita is a key determinant to increase energy consumption in low income, middle income, South Africa, MENA and the World. This suggests that increase in GDP would consume more energy and implementing of the energy conservation policies and energy demand management policies may not have negative impact on economic growth [28]. Energy-saving practices and technologies, such as hybrid vehicles and high-efficiency natural gas power plants, would help countries in the OECD [9]. The results indicate that FDI plays a significant role in increasing the demand for energy in middle income, non-OECD and OECD region which implies that FDI induce a shift towards more energy intensive production via a change in the sectoral composition of production. In case of low income regions, FDI reduces energy intensity via technology transfers [17]. No country is an energy "island" and the interactions between different fuels, markets and prices are intensifying. The results of relative price on energy consumption is mixed in different regions, on one hand, relative prices decreases energy consumption (i.e., low income region, high income: non-OECD, and MENA region) while on the other hand, relative prices increased significantly energy demand (i.e., middle income). In some regions i.e., high income non-OECD, South Africa and the World doesn't have any significant impact between relative prices and energy consumption. The result suggests that price relationships between regional gas markets are set to strengthen as liquefied natural gas trade becomes more flexible and contract terms evolve, meaning that changes in one part of the world are more quickly felt elsewhere. Within individual countries and regions, competitive power markets are creating stronger links between gas and coal markets, while these markets also need to adapt to the increasing role of renewables and, in some cases, to the reduced role of nuclear power [19]. The financial development plays a vital role in the economic development of an economy. The results of financial development indicator which is here to used as broad money supply (M_2) exerts positive, negative and no impact with the energy consumption in different regions of the world. There is a positive relationship exerts between M_2 and energy consumption in middle income, high income non-OECD and MENA, while, negative relationship in high income OECD and no relationship found in South Africa and aggregate data of World. The results imply that financial development promotes business activities and adds to demand for energy via cheaper credit. Easy credit facilitates purchase of auto, home and appliances; and adds to energy use. As a long run goal, financial development strategy should be major goal for a sound energy infrastructure and thus achieve efficiency in the overall energy use [22]. CEROI [7] suggests some possible implementation strategies regarding reduce air pollution in different regions of the world i.e.,

- Setting targets for the improvement of air quality in consultation with local communities.
- Developing air quality indicators.
- Developing an air quality monitoring network.
- Developing 'good neighbor' agreements between industries and adjacent communities for reduction of air emissions over time.
- Developing regulatory and economic instruments with national and provincial authorities.
- Enforcement of legislation on air pollution.
- Encourage the use of new technologies to reduce air emissions at source.
- Lobbying national government to waive import duties on clean technology and machinery and
- Land-use control instruments.

The Middle East region has the highest per capita carbon footprint in the world which can be offset by mass deployment of energy-efficient systems. An improved energy efficiency plan for MENA region (in both supply and use) would help in mitigating the domestic and global environmental impact of energy by reducing both atmospheric particulate matter and GHG emissions ([2]).

Energy efficiency is widely recognized as a key option in the hands of policy makers but current efforts fall well short of tapping its full economic potential. World scenario shows how tackling the barriers to energy efficiency investment can unleash this potential and realize huge gains for energy security, economic growth and the environment. These gains are not based on achieving any major or unexpected technological breakthroughs, but just on taking actions to remove the barriers obstructing the implementation of energy efficiency measures that are economically viable. Successful action to this effect would have a major impact on global energy and climate trends, compared with the New Policies Scenario [19]. This study recommended that these regions should increase energy productivity by increasing energy efficiency, implementation of energy savings projects, energy conservation, and energy infrastructure outsourcing to achieve its financial development and GDP growth and to increase their investment on energy projects to achieve the full energy potential [1]. For an economy to grow, it needs energy. To sustain and enhance economic progress around the world, we must continue to improve the value created through the use of energy sources, address related environmental challenges and safely expand the world's commercially viable energy supplies through technological advancements. These efforts will continue to improve energy diversify and reduce the energy-intensity of our economies, helping expand economic prosperity and support energy security [9].

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